SYLLABUS & PROGRAMME STRUCTURE

Physics

(Honours)

(Choice Based Credit System)

(Effective from the Academic Session 2017-2018)

Fourth Semester

MAHARAJA BIR BIKRAM UNIVERSITY

AGARTALA, TRIPURA: 799004

PROGRAMME STRUCTURE

Structure of Proposed CBCS Syllabus B.A / B.Sc / B.Com Honours

Semester	Core Course (14) Honours	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (2)	Discipline Specific Elective (DSE) (4)	Generic Elective (GE) (4)
1	**C1** **C2**	**AECC1: Environmental Science**			**GE1** (Paper-I of selected subject other than Hons subject)
2	**C3** **C4**	**AECC2 : (English/MIL (Communication)**			**GE2** (Paper-II of selected subject other than Hons subject)
3	**C5** **C6** **C7**		**SEC1**		**GE3** (Paper-III of selected subject other than Hons subject)
4	**C8** **C9** **C10**		**SEC2**		**GE4** (Paper-IV of selected subject other than Hons subject)
5	**C11** **C12**			**DSE1** **DSE2**	
6	**C13** **C14**			**DSE3** **DSE4**	

Semester – IV
Core Course- Paper-VIII
MATHEMATICAL PHYSICS - III

(Credits: Theory-04, Practicals-02)
[Marks: Theory- 70 (60 + Inter: 10), Practical- 30 (20 + Inter: 10)]
Theory: (60+12) Lectures

The emphasis of the course is on applications in solving problems of interest tophysicists. Students are to be examined on the basis of simple problems, seen and unseen along with the theory.

Unit-I
(Intro.+ Recap.+ problems hints/practice) Lectures)]

Complex Analysis (Part-1 :)
Brief Revision of Complex Numbers and their GraphicalRepresentation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers.Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Necessary and sufficient condition, Harmonic and conjugate function,Cauchy –Reimann equation in polar form,Examples of analytic functions.

Unit-II
[15 +3 (Intro.+ Recap. + problems hints/practice) Lectures)]

Complex Analysis (Part-2:)
Singular functions: poles and branch points, order ofsingularity, branch cuts. Integration of a function of a complex variable. Cauchy'sInequality. Cauchy's Integral formula. Simply and multiply connected region. Laurentand Taylor's expansion. Residues and Residue Theorem. Application in solvingDefinite Integrals.

Unit-III
[15 +3 (Intro.+ Recap.+ problems hints/practice) Lectures)]

Integrals Transforms:
Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fouriertransform of trigonometric, Gaussian, finite wave train & other functions.Representation of Dirac delta function as a Fourier Integral. Fourier transform ofderivatives, Inverse Fourier transform, Convolution theorem. Properties of Fouriertransforms (translation, change of scale, complex conjugation, etc.). Three dimensionalFourier transforms with examples. Application of Fourier Transforms to differentialequations: One dimensional Wave and Diffusion/Heat Flow Equations.

Unit-IV
[15 +3 (Intro.+ Recap.+ problems hints/practice) Lectures)]

Laplace Transforms:
Laplace Transform (LT) of Elementary functions. Properties ofLTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivativesand Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function,Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT.Application of Laplace Transforms to 2nd order Differential Equations: DampedHarmonic Oscillator, Simple Electrical Circuits, Coupled differential equations of 1storder. Solution of heat flow along infinite bar using Laplace transform.

N.B: Simple Problems (covering Unit-I, II, III & IV) using formulae of these respective units to be practiced.

Reference Books:

1. *Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press.*
2. *Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications*
3. *Complex Variables, A.S.Fokas&M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press*
4. *Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press*
5. *Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill.*
6. *First course in complex analysis with applications, D.G. Zill and P.D. Shanahan,1940, Jones & Bartlett.*

PHYSICS PRACTICAL-C VIII LAB

60 Lectures

Scilab/C^{++} based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations:

   $dy/dx = e^{-x}$ with $y = 0$ for $x = 0$

   $dy/dx + e^{-x}y = x^2$

   $d^2y/dt^2 + 2\, dy/dt = -y$

   $d^2y/dt^2 + e^{-t}dy/dt = -y$

2. Dirac Delta Function:

   Evaluate $\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{\frac{-(x-2)^2}{2\sigma^2}} (x+3)dx$, for $\boldsymbol{\sigma}$ = 1, 0.1, 0.01 and show it tends to 5.

3. Fourier Series:

   Program to sum $\sum_{n=1}^{\infty}(0.2)^n$

   Evaluate the Fourier coefficients of a given periodic function (square wave)

4. Frobenius method and Special functions:

   $\int_{-1}^{+1} P_n(\mu)P_m(\mu)d\mu = \delta_{n,m}$

   Plot $P_n(x)$, $j_v(x)$

Show recursion relation

5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).

6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.

7. Evaluation of trigonometric functions e.g. *sin θ,* Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.

8. Compute the n^{th} roots of unity for $n = 2, 3,$ and 4.

9. Find the two square roots of $-5+12j$.

10. Integral transform: FFT of e^{-x^2}

11. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace's transform.

12. Solve Kirchoff's Voltage law for any loop of an arbitrary circuit using Laplace's transform.

13. Perform circuit analysis of a general LCR circuit using Laplace's transform.

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
- https://web.stanford.edu/~boyd/ee102/**laplace**_ckts.pdf
- ocw.nthu.edu.tw/ocw/upload/12/244/12handout.pdf

Semester – IV
Core Course- Paper-IX
ELEMENTS OF MODERN PHYSICS

(Credits: Theory-04, Practicals-02)

[Marks: Theory- 70 (60 + Inter : 10), Practical- 30 (20 + Inter: 10)]

Theory: (60+12) Lectures

Unit-I

[15 +3 (Intro.+ Recap.+ problems hints/practice) Lectures)]

Black Body Radiation & Dual nature of Photon and elementary Particle:

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. DeBroglie wavelength and matter waves; Davisson-Germer experiment. Wave descriptionof particles by wave packets. Group and Phase velocities and relation between them.Two-Slit experiment with electrons. probability. Wave amplitude and wave functions.

Unit-II

[15 +3 (Intro.+ Recap.+ problems hints/practice) Lectures)]

Quatum Mechanics-I:

Position measurement- gamma ray microscope thought experiment; Wave-particleduality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pairof variables): Derivation from Wave Packets impossibility of a particle following atrajectory; Estimating minimum energy of a confined particle using uncertaintyprinciple; Energy-time uncertaintyprinciple- application to virtual particles and range ofan interaction. Two slit interference experiment with photons, atoms and particles; linear superpositionprinciple as a consequence; Matter waves and wave amplitude; Schrodinger equation fornon-relativistic particles; Momentum and Energy perators; stationary states; physicalinterpretation of a wave function, probabilities and ormalization; robability andprobability current densities in one dimension.

Unit-3Unit-III

[15 +3 (Intro.+ Recap.+problems hints/practice) Lectures)]

Quantum Mechanics-II & Laser:

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions,normalization; Quantum dot as example; Quantum mechanical scattering and tunneling in one dimension-across a step potential & rectangular potential barrier.

Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulatedemissions. Optical Pumping and Population Inversion. Three-Level and Four-LevelLasers. Ruby Laser and He-Ne Laser. Basic lasing.

Unit-IV

[15 +3 (Intro.+ Recap.+ problems hints/practice) Lectures)]

Nuclear Physics and Radioactivity:

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility ofan electron being in the nucleus as a consequence of the uncertainty principle. Nature ofnuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and bindingenergy, Nuclear Shell Model and magic numbers.

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life;Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino;Gamma ray emission, energy-momentum conservation: electron-positron pair creationby gamma photons in the vicinity of a nucleus.

Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature offragments and emission of neutrons. Nuclear reactor: slow neutrons interacting withUranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

N.B: Simple Problems (covering Unit-I, II, III & IV) using formulae of these respective units to be practiced.

Suggested Readings:

1. *Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.*
2. *Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill*
3. *Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.*
4. *Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010,*
5. *Cengage Learning.*
6. *Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill*
7. *Quantum Mechanics: Theory & Applications, A.K.Ghatak&S.Lokanathan, 2004, Macmillan.*

Additional Books for Reference

1. *Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.*
2. *Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.*
3. *Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.*
4. *Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.*
5. *Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill*

PHYSICS
PRACTICAL
Core Course – IX
LAB (Modern Physics)

1. Measurement of Planck's constant using black body radiation and photo-detector.
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet/ by any method.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source or any monochromatic light using diffraction of double slits.
13. To determine (1) wavelength and (2) angular spread of He-Ne laser/ any source using plane diffraction grating.

Suggested Readings:

1. *Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.*
2. *Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.*
3. *A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Edn, 2011,Kitab Mahal.*

More Practical Reference Books :

1. *An Advanced Course in Practical Physics ,D. Chattopadhyay and P.C. Rakshit.*
2. *Advanced Practical Physics Vol.I&Vol.II.Dr.Basudev Gosh.*
3. *A Text Book of Practical Physics, Dr.Basudev Gosh.*
4. *Advanced Practical Physics Vol.I&Vol.II, K. G. Mazumdar.*
5. *B.Sc Practical Physics, C.L. Arora.*

———————

Semester – IV
Core Course- Paper-X
ANALOG SYSTEMS AND APPLICATIONS

(Credits: Theory-04, Practicals-02)
[Marks: Theory-70 (60 + Inter: 10), Practical- 30 (20 + Inter: 10)]
Theory: (60+12) Lectures

Unit-I

[15 +3 (Intro.+ Recap. + problems hints/practice) Lectures)]

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow Mechanism in Forward and Reverse Biased Diode.

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell.

Unit-II

[15 +3 (Intro.+ Recap.+ problems hints/practice) Lectures)]

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CEand CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers.

Unit-III

[15 +3 (Intro.+ Recap.+ problems hints/practice) Lectures)]

Coupled Amplifier: Two stage RC-coupled amplifier and its frequency response.

Feedback in Amplifiers: Effects of Positive and Negative Feedback on InputImpedance, Output Impedance, Gain, Stability, Distortion and Noise.

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution.
A/D Conversion (successive approximation)

Unit-IV

[15 +3 (Intro.+ Recap.+ problems hints/practice) Lectures)]

Operational Amplifiers (Black Box approach): Characteristics of an Ideal andPractical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response.CMRR. Slew Rate and concept of Virtual ground.

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3)Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossingdetector (8) Wein bridge oscillator.

N.B: Simple Problems (covering Unit-I, II, III & IV) using formulae of these respective units to be practiced.

Suggested Readings:

1. *Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.*
2. *Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.*
3. *Solid State Electronic Devices, B.G.Streetman&S.K.Banerjee, 6th Edn.,2009, PHI Learning*
4. *Electronic Devices & circuits, S.Salivahanan&N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill*
5. *OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall 30*
6. *Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.*
7. *Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer*
8. *Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India*
9. *Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning*
10. *Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India*

PHYSICS
PRACTICAL
Core Course – Paper - X
LAB : ANALOG SYSTEM AND APPLICATION

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To study the various biasing configurations of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt`s oscillator.
11. To design a digital to analog converter (DAC) of given specifications.
12. To study the analog to digital convertor (ADC) IC.
13. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
14. To design inverting amplifier using Op-amp (741,351) and study its frequency response
15. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
16. To study the zero-crossing detector and comparator
17. To add two dc voltages using Op-amp in inverting and non-inverting mode
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an Integrator.
20. To investigate the use of an op-amp as a Differentiator.
21. To design a circuit to simulate the solution of a 1st/2nd order differential equation.

Suggested Readings:

1. *Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.*
2. *OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.*
3. *Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.*
4. *Electronic Devices & circuit Theory, R.L. Boylestad& L.D. Nashelsky, 2009, Pearson*